PHASE TO PHASE

User manual Vision Cable 1.2

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Phase to Phase BV
Utrechtseweg 310
Postbus 100
6800 AC Arnhem
The Netherlands
T: +31 26 352 37 00
F: +31 26 352 37 09
www.phasetophase.com

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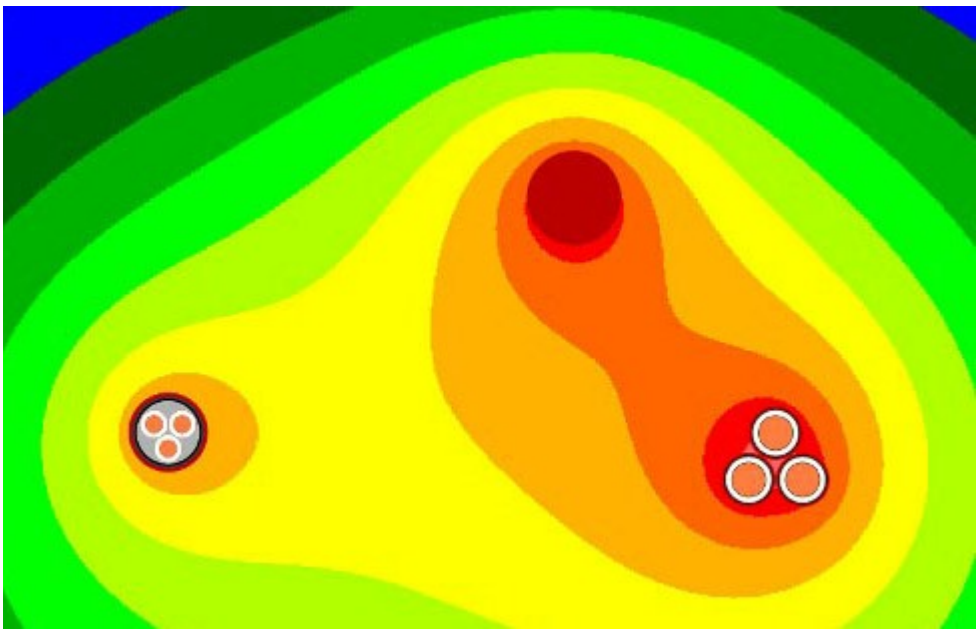
1 Introduction



Vision *Cable analysis* is a practical computer program for calculation of the electric current rating of cables. The calculation method is based on both the IEC 60287 and the IEC 60853 standard. Thanks to the logical and user-friendly user interface the computer program is easy to learn.
The IEC 287 standard is used for calculation of the stationary cable current rating. The results are the basis for the dynamic calculations according to the IEC 60853 standard. Using this standard the cyclic and emergency current ratings can be calculated.

The user should concentrate on the hot spots in the cable connection, caused by dry ground and neighbouring heat sources. Also the correct ground temperature and ground thermal resistance should be chosen carefully.

With respect to the application of Vision *Cable analysis*, Phase to Phase BV can not be held liable for any misinterpretations of the IEC norms or incorrect use of the software.

Any questions or remarks can be made by e-mail to: cable@phasetophase.nl.

2 Installation

Network installation
Vision *Cable Analysis* runs using the ***Microsoft.Net framework***. Since Microsoft protects this framework at a high level it is not possible to run any software on the network using default settings. Vision *Cable analysis* can be run from the network after special settings have been made on your PC. For more information, please contact by e-mail: cable@phasetophase.nl.

The installation process is as follows:

- download the installation program: http://www.phasetophase.nl/download/VisionCable.exe.
- start VisionCable.exe
- If the installation program indicates that the Microsoft .NET Framework has not been installed, do the following:
  - close the installation program
  - browse to: http://www.microsoft.com/downloads
  - choose: .NET Framework Version 1.1 Redistributable Package
  - download the software (23 Mb)
  - start the program dotnetfx.exe and follow the instructions
  - start the program VisionCable.exe
- follow the instructions to install Vision *Cable analysis*

3 Getting Started

Vision *Cable analysis* is a practical computer program for calculation of the electric current rating of cables. The calculation method is based on both the IEC 60287 and the IEC 60853 standard. Thanks to the logical and user-friendly user interface the computer program is easy to learn.
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The user should concentrate on the hot spots in the cable connection, caused by dry ground and neighbouring heat sources. Also the correct ground temperature and ground thermal resistance should be chosen carefully.

The user interface has been subdivided into two parts: the worksheet and the cable type editor. In the worksheet all cable connections can be defined in or above the ground. The cable editor is the tool to define the cables. All cables are stored in the cable database. Cables can be added, modified and deleted.

In 6 steps this Getting Started shows the shortest route from scratch to the first cable calculations.

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3.1 Opening a new worksheet

Directly after starting the program, Vision Cable analysis shows a new empty worksheet, showing the ground with its temperature and the air with its temperature. In this worksheet all cables and results will be presented graphically.

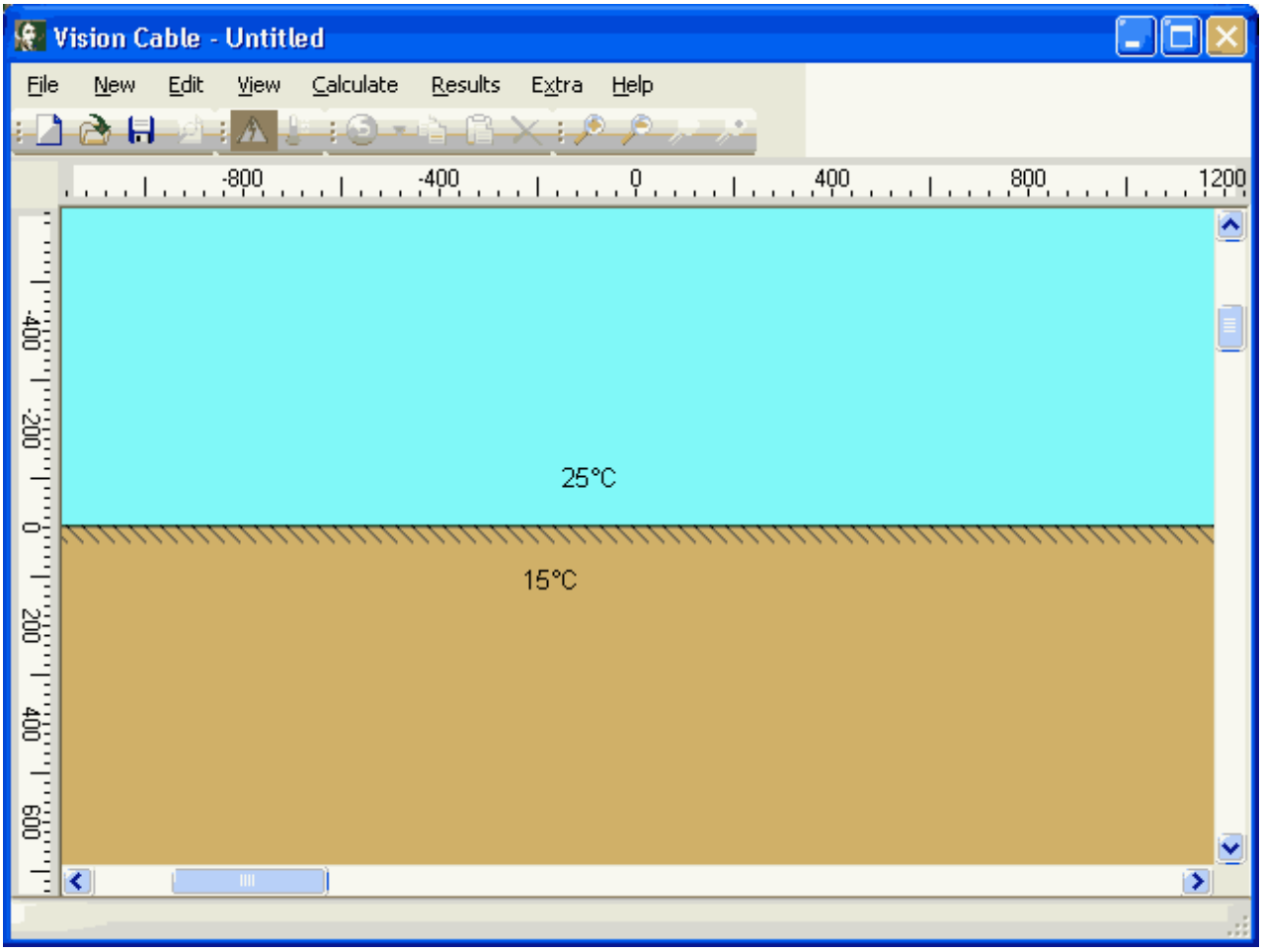


Figure 1: Vision Cable analysis worksheet

In the worksheet all cable circuits and heat sources can be defined. The next configurations are possible:
- one circuit (or multiple) above the ground
- one or more circuits and heat sources in the ground

3.2 Defining the environment

It is always necessary to define the environmental conditions. The worksheet shows the environmental temperatures. Other conditions depend on the situations for buried cables or cabled laid in free air.

For cables laid in free air apply:
- environmental air temperature
- solar radiation: yes or no.

These conditions can be defined by right-mouse clicking in the worksheet on a spot above the ground level. A pop-up menu appears. Choose: **Edit** and **In air**. The air temperature can defined in steps of 5 degrees Celsius.

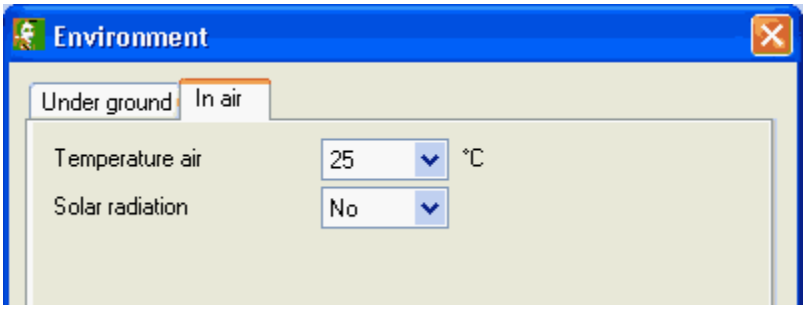


Figure 2: Environmental conditions in free air

For buried cables apply:
- drying out of soil: none/partial/prevent
- environmental ground temperature
- ground thermal resistance

These conditions can be defined by right-mouse clicking in the worksheet on a spot below the ground level. A pop-up menu appears. Choose: **Edit** and **Under ground**. The ground temperature can defined in steps of 5 degrees Celsius.

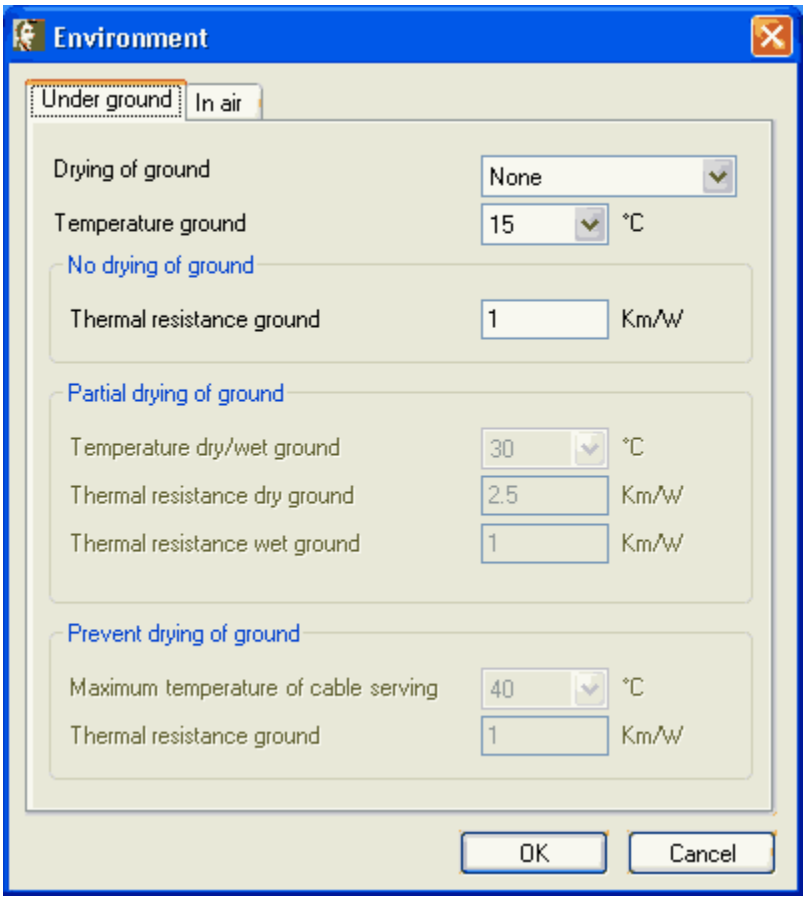


Figure 3: Environmental conditions under ground

In most countries the soil can be moist. In cases of heavy loaded cables or crossings this soil can be dried out. This can lead to a "hot spot" in the cable connection, limiting the whole cable connection ampacity. The specific thermal resistance for dried ground can be 2.5 Km/W.

3.3 Adding a cable

A new cable circuit can be added using: **New | Circuit** from the menu. A dialogue form appears for defining the circuit properties:

- cable type
- lay
- current

Cable type

On the tab-sheet **Cable type** the cable can be choosen from the cable database. A filter assists in the selection procedure. The filter criteria are:

- isolation (plastic or no plastic)
- number of cores (1 or 3)
- voltage level (phase-to-phase voltage)

If a cable type has been chosen, a picture of the cable cross-section will be shown. In this example: a single-core 10 kV XLPE-cable of 95 mm2.

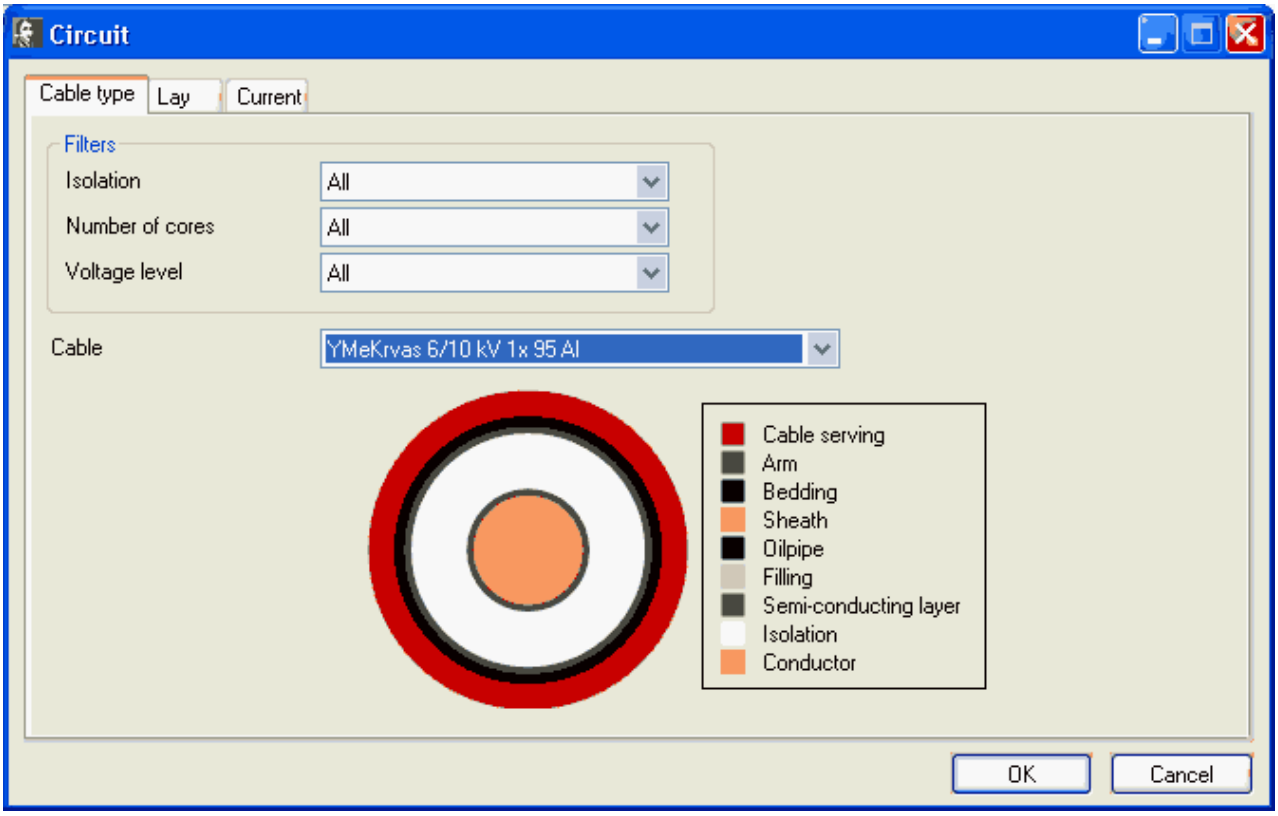


Figure 4: Selecting a cable type

Lay

After selecting a cable type, the laying configuration has to be defined in the tab-sheet **Lay**. This also defines the laying in the ground or in the free air.

In this example the cable is buried at a depth of 1 m. The cables core-to-core distance is twice the cable diameter (button **2xDe**) in flat formation. The sheets have been bonded at a single point. Leave the form using **OK**.

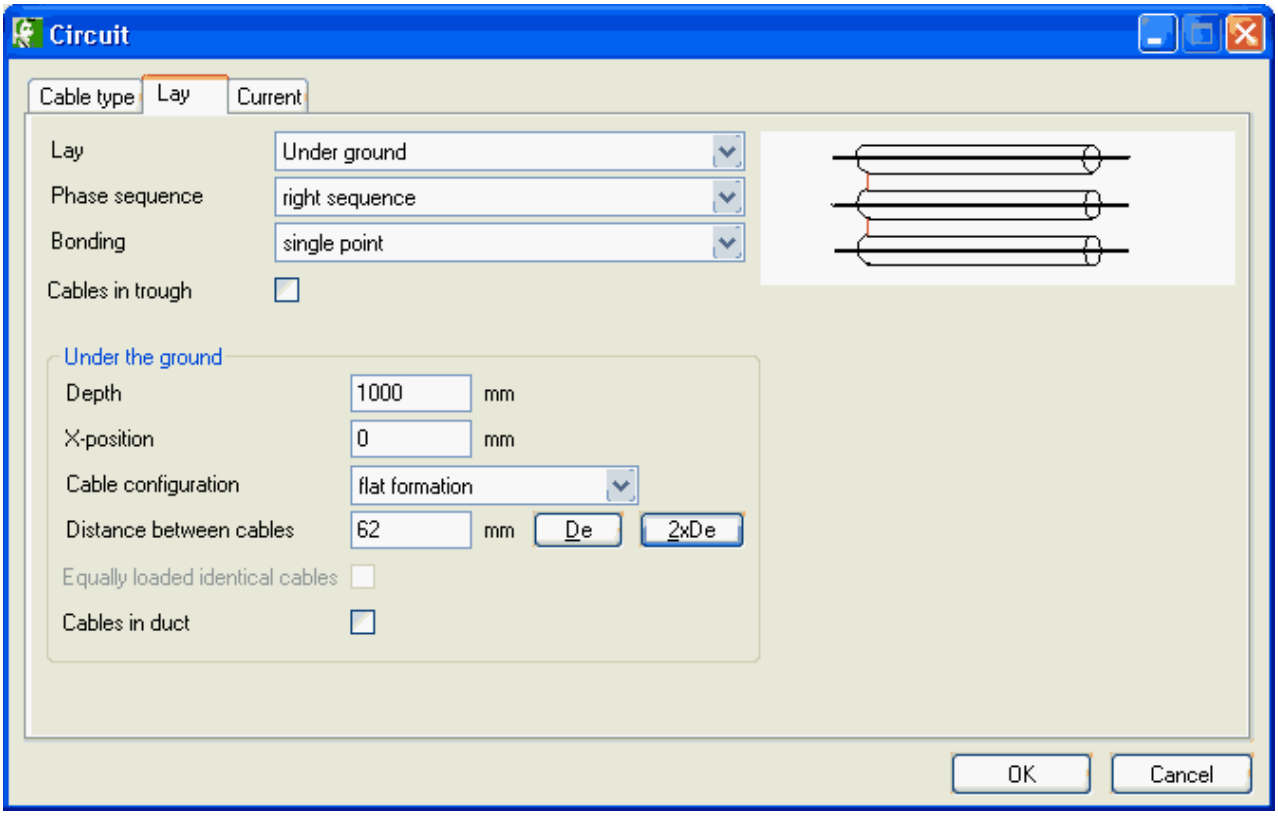


Figure 5: Defining the lay

The cable circuit can be moved in the worksheet using the mouse. The cable ampacity will be calculated automatically.

3.4 Interpreting the results for the stationairy situation

After defining the cable type and the environment, Vision *Cable analysis* automatically calculates the stationary cable ampacities. All results will be presented in the worksheet. The zoom-functions are:

- use the zoom-buttons (+) and (-) or
- select the cable circuit (by clicking with the left-mouse button or by drawing a rectangle while the left-mouse button held pressed down) and choose the most right **Zoom selected**speed-button.

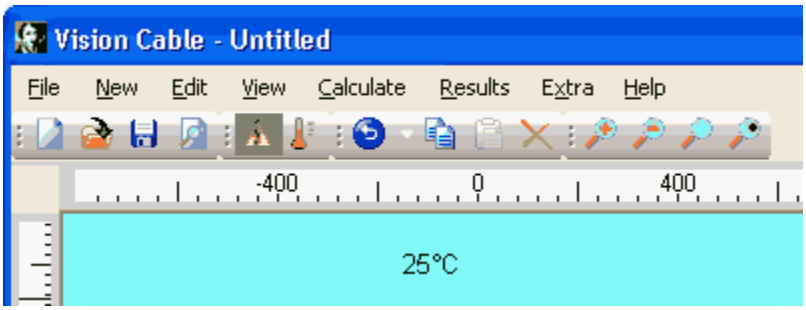


Figure 6: Zoom functions

After zooming in the calculated stationary cable ampacity and the temperatures of conductor, sheet, armour and outer covering will be presented.

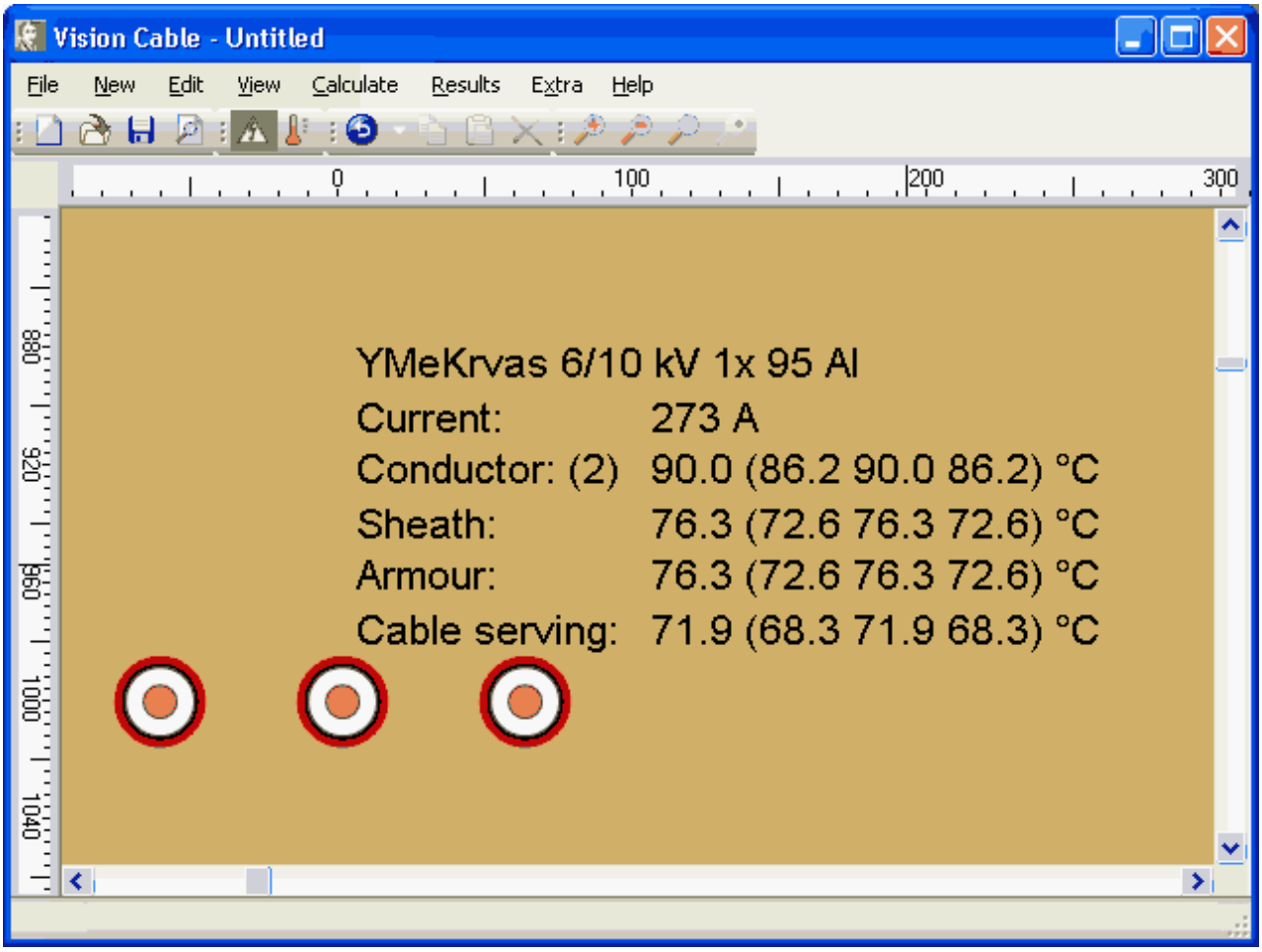
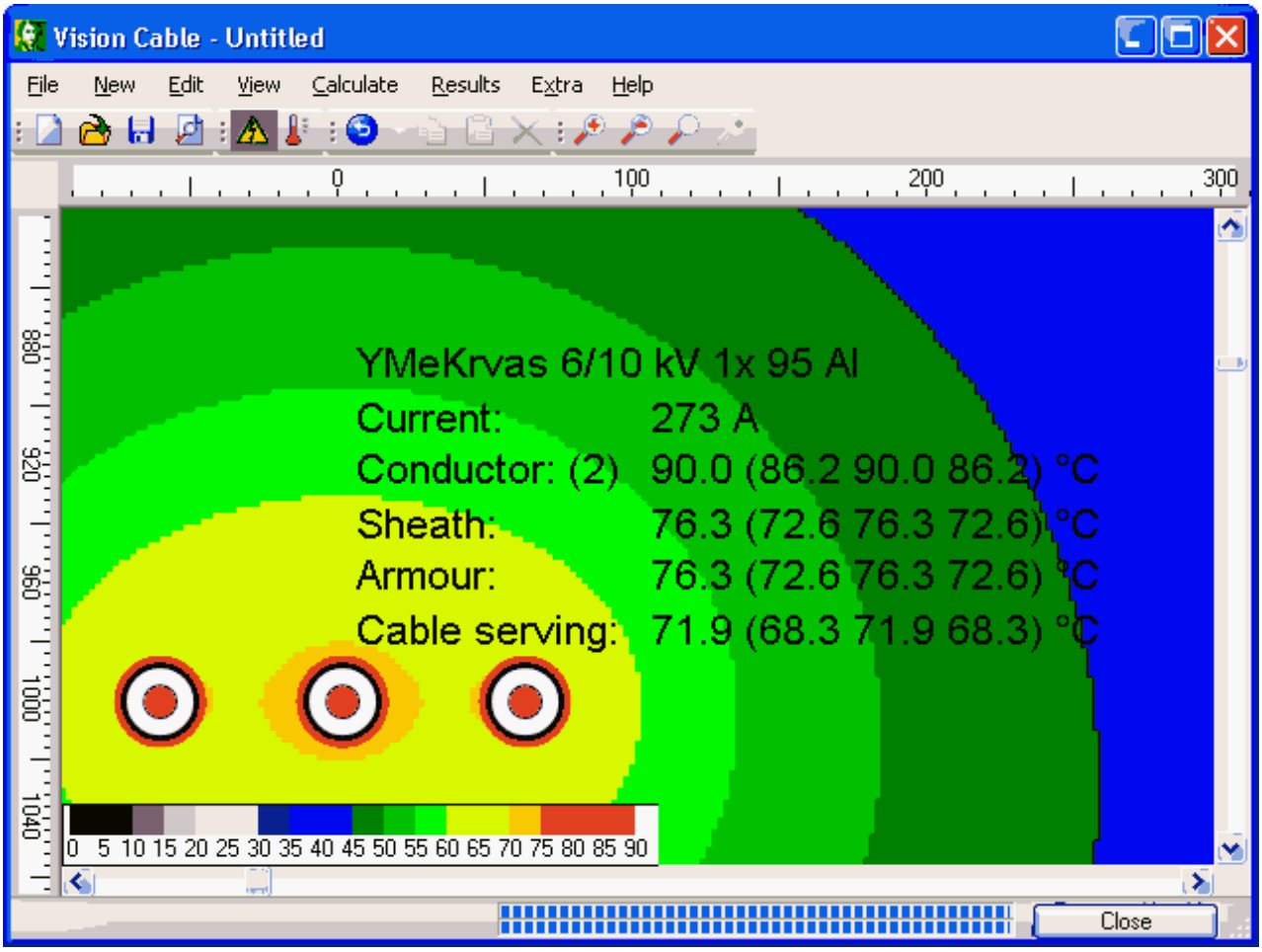

Vision Cable - Untitled
File New Edit View Calculate Results Extra Help
YMeKrvas 6/10 kV 1x 95 Al
Current: 273 A
Conductor: (2) 90.0 (86.2 90.0 86.2) °C
Sheath: 76.3 (72.6 76.3 72.6) °C
Armour: 76.3 (72.6 76.3 72.6) °C
Cable serving: 71.9 (68.3 71.9 68.3) °C

Figure 7: Calculated stationary cable ampacity

The worksheet shows the temperatures of the hottest cable. Between brackets the temperatures of all cables of this circuit are presented. In this case the center cable is the hottest one. The results can be examined in detail by selecting the cable circuit and choosing: **Results | General**.

A function has been added to calculate the underground temperature image for the stationary case. From the menu choose: **Calculate | Temperature range**. The temperatures are presented in steps of 5 degrees Celsius.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Cable serving: 71.9 (68.3 71.9 68.3) °C
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Close

Figure 8: Temperature image

3.5 Calculating the cyclic load

The cyclic load calculation determines the amount of extra load above the stationary cable ampacity, provided that the current follows a daily cyclic pattern of 24 values. According to the IEC 60853 norm the largest current of such a cyclic load can be larger than the stationary ampacity. To start this calculation, select the cable circuit and from the main menu choose: **Calculate | Cyclic current**.

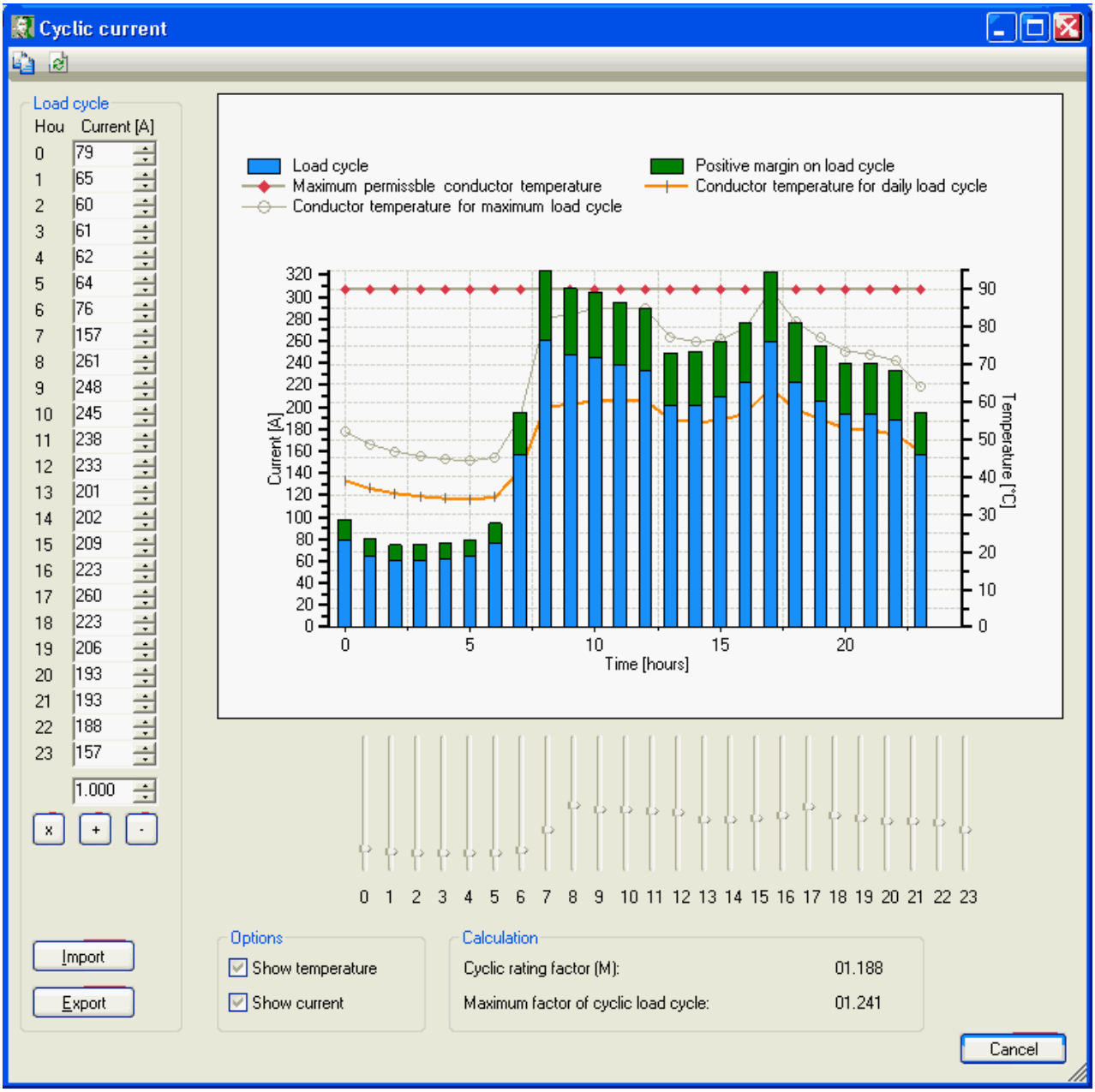

Figure 9: Cyclic current calculation form

The screen shows the default load cycle in a bar chart. The values are presented on the left-hand side. These values correspond with the blue parts of the bar chart. Behind the bar chart the conductor temperature for this current profile has been plotted (orange line).

A user defined load cycle can be exported by using the button **Export**. Previously saved load cycles can be imported by using the button **Import**. All imported current values are limited to two times the stationary ampacity.

This example concentrates on the default load cycle.

The "Cyclic rating factor (M)" indicates the maximum value of the load cycle as factor of the stationary ampacity. In this example:

$$Imax,cyclic = M \times Imax,stationary = 1{,}189 \times 273 = 325\ A.$$

The "Maximum factor of cyclic load cycle" is the maximum multiplication factor for all values of the load cycle. In this example: 1.25.

The cyclic calculation is only possible for configurations of one circuit.

3.6 Calculating the emergency load

The IEC 60853 norm describes the "Emergency Load" calculation, for determination of a maximum duration of a stepwise change of current in case of an emergency. To start the calculation, from the main menu choose: **Calculate | Maximum load**.

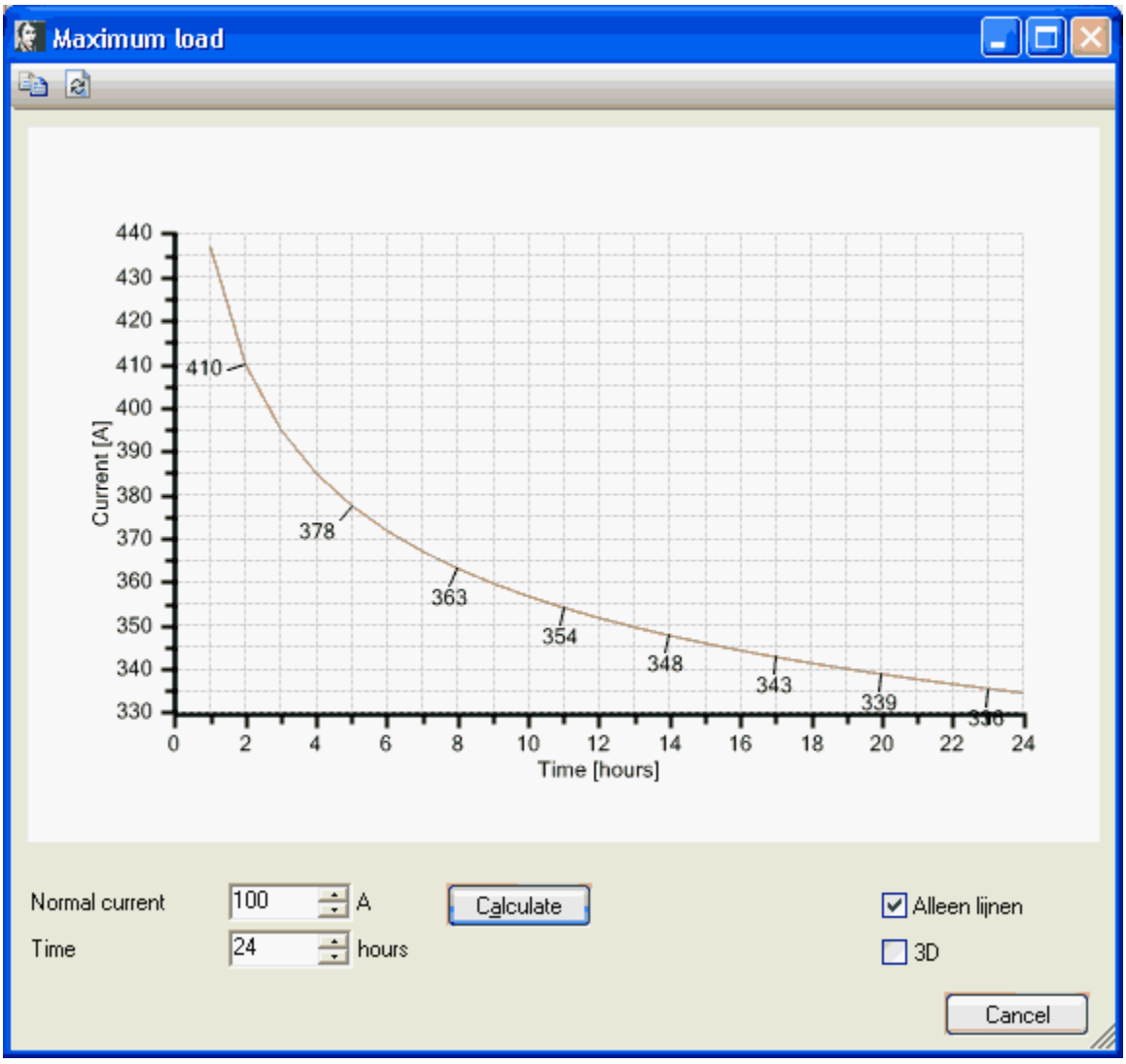

Figure 10: Maximum emergency load

The result is a graph, presenting the emergency load a function of the emergency duration. In this example, starting with a pre-emergency load of 100 A, the 8 hours emergency load may be 363 A. After this emergency, the cable load must be less than or equal to the stationary ampacity.

3.7 Defining a cable type

Vision *Cable analysis* uses a database of cable types. This database can be user defined using the Cable type editor. The editor will be invoked by chosing from the main menu: **Extra | Cable type editor**.

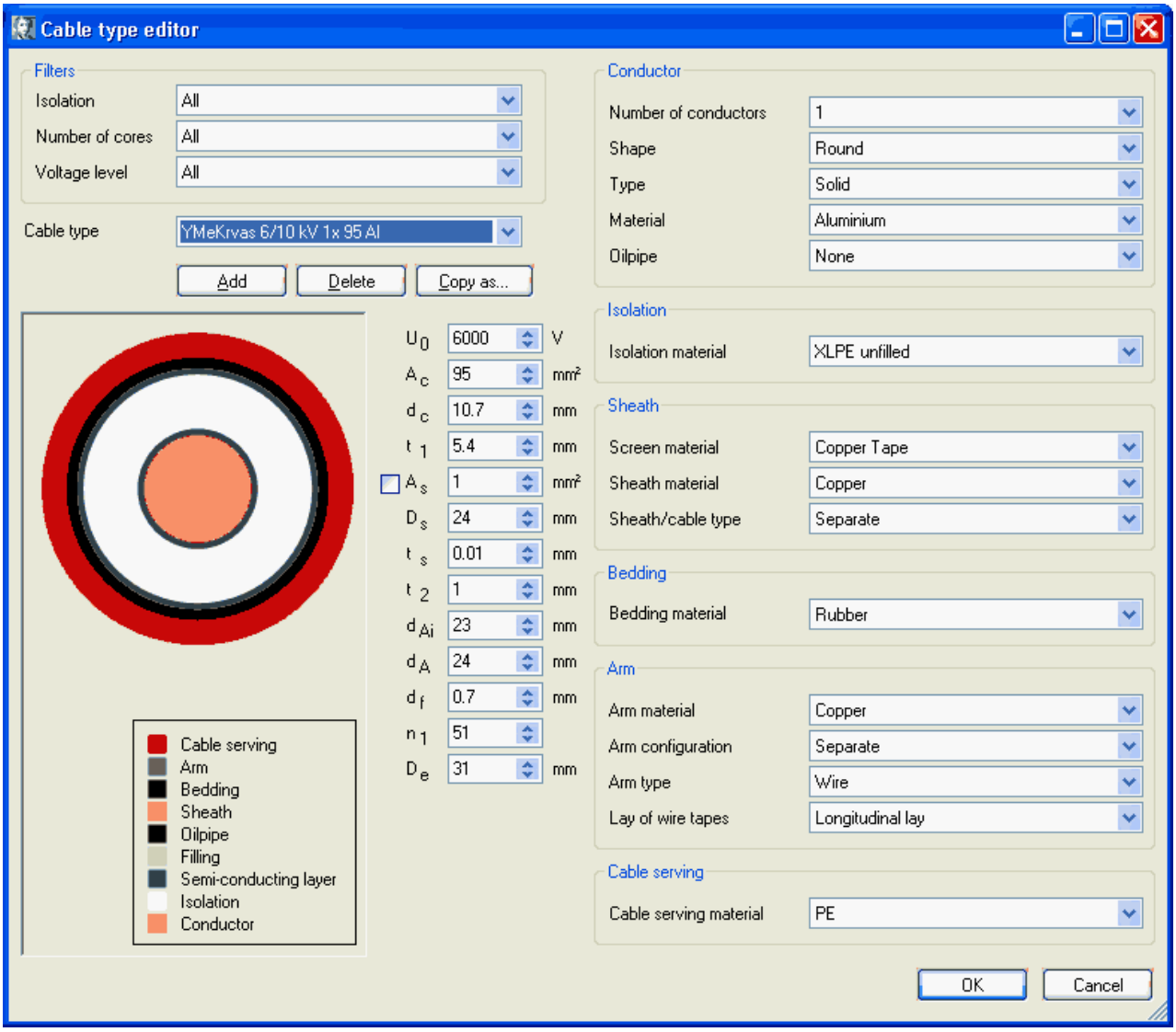

Figure 11: Cable type editor

In the upper left part of the form an existing cable can be selected from the database. Once selected, this cable can be modified, copied or deleted. Also, a new cable can be defined and added to the database. In the middle part of the form the constructional sizes are presented. In the right-hand side of the form the material properties are presented.

Changes in sizes will be graphically presented in the cable cross-sectional diagram. The diagram is drawn with

reference to the outer covering. This example schows:

- Uo : Rated voltage (phase to ground)
- Ac : conductor cross-sectional area
- dc : conductor diameter
- t1 : isolation thickness
- As : screen cross-sectional area
- Ds : screen diameter
- ts : screen thickness
- t2 : bedding thickness
- dAi : armour internal diameter
- dA : armour external diameter
- df : armour wire diameter
- n1 : armour number of wires
- De : outer diameter

In this example the screen has been constructed with a screen of copper tape and wires. The copper wires have been defined as "armour".

Changes, made in the cable type editor, will be saved after leaving the form with "OK".